India's Marine Fisheries Sector Under Changing Climate

A Synthesis of BOBP Studies & Reports on Adaptation Strategies & Policy Perspectives

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Preparation of the document

This report is a synthesis of studies and outcomes from workshops conducted by Bay of Bengal Programme Inter-Governmental Organisation (BOBP-IGO) during 2019-23 in response to the evolving climate risks and other risks in the marine fisheries sector and the need for building resilience in India.

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Foreword

India, with its vast coastline, is intricately linked to the ocean and seas. Our history, culture, economy, and even our culinary preferences were shaped by the surrounding nourishing waters. The marine fisheries sector, in Indian context, is not only a vital source of livelihood for millions but has also been a testament to the symbiotic relationship between humans and the oceans.

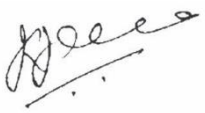
However, the changing global climate, combined with anthropogenic pressures, has cast a shadow over this relationship. The challenges the fisheries sector now faces are unprecedented. Rising sea temperatures, altered tidal patterns, and the shift in fish stocks are not mere scientific observations anymore; they are everyday realities for our fisherfolk.

The Indian Council of Agricultural Research (ICAR) has taken pioneering steps to prepare adaptation strategies for climate change. The National Innovations for Climate Resilience Agriculture (NICRA), network project of ICAR has made significant contributions to preparing the national strategy for climate resilient agriculture including fisheries.

I am happy to introduce this timely and pertinent compilation, prepared by the BOBP-IGO, which is essentially a synthesis of various research studies and expert consultations coordinated by the BOBP-IGO in recent years. This highlights the need for strengthening collaboration, bridging knowledge gap, and building synergies to collectively deal with climate change. The policy recommendations are not just reactive measures to combat the challenges but are proactive strategies to harness opportunities and ensure sustainable growth. The emphasis on community engagement, real-time data monitoring, green infrastructure, and capacity building stands out. These elements ensure that our approach is holistic, balancing the immediate needs of our fisherfolk with the long-term sustainability of our marine ecosystems.

BOBP-IGO has been working closely with the ICAR fisheries institutes and the partnership is rewarding as ICAR fisheries institutions bring science par excellence while the BOBP-IGO brings in international experiences and best practices. The initiatives of the IGO taken in close coordination with the national research institutes aid in supplementing the national actions.

I commend BOBP-IGO for bringing out this document, which is a clarion call for action and a testament to India's commitment to its marine heritage. I am confident that with the concerted efforts of policymakers, researchers, fisherfolk, and other stakeholders, the horizon ahead is bright and promising.



(J.K. Jena)
Deputy Director General (Fisheries)
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Preface

This compilation, built on the strong research and development initiatives by the national and international agencies with respect to building resilience to climate change in the marine fisheries sector in India, is the culmination of rigorous research and stakeholder consultations conducted by the Bay of Bengal Programme Inter-Governmental Organisation (BOBP-IGO) during 2019-2023.

The brief provides adaptive strategies to navigate the multifaceted challenges posed by climate change, with a focus on ensuring progress towards the pillars of sustainability: human, social, economic, environmental, and institutional.

Aligned with global agreements and instruments on climate change and fisheries management, this report emphasizes the need for cooperative action and shared knowledge. We express our sincere gratitude to our colleagues from fisheries R&D organizations under the Indian Council of Agricultural Research (ICAR), national laboratories, academic institutions, fisher community organizations and experts from India and also experts from the region for sharing knowledge and experiences and extending support.

We hope that this document would strengthen the drive of the policymakers, researchers, and stakeholders in guiding the marine fisheries sector of India towards a sustainable and resilient future in the era of climate change.

(P. Krishnan)
Director, BOBP-IGO

A Climate Change Adaptation Policy Space: A 10000 Foot View

(Start with green box, blue side shows external actions and orange side shows internal actions needed to support the external action)

Key Partners

- Environmental organizations and fisheries research institutions.
- Local governments and regulatory bodies.
- Financial institutions and insurers.
- Neighbouring countries and international/regional fisheries organizations.
- Fish Producers Organizations/ Cooperatives.

Key Activities

- Regular scientific surveys of fish stock health.
- Fisheries MCS
- Implementation of no-fishing zones in breeding grounds.
- Engagement with neighbouring countries for shared fish stocks.
- Risk management activities, including climate finance and insurance mechanisms.
- Building of credit access and scheme compatibility
- Technology development
- Training programmes

Key Resources

- Healthy fish stocks.
- Marine ecosystem knowledge and expertise.
- Infrastructure aligned with national development goals.
- Regulatory and compliance bodies.

Value Propositions/ Targets

- Sustainable and healthy fish stocks ensuring long-term economic stability.
- Branding and premium pricing for sustainably caught fish.
- Conservation of marine ecosystems for future generations.
- Alignment with international guidelines and standards for responsible fishing.
- Insurance for business disruptions and access to credit market.
- Developing green infrastructure.
- Vibrant fishing communities trained in sustainable fishing practices.
- Empowered fisher women

Stakeholder Relationships

- Involving fisher communities in decision-making processes.
- Regular feedback loops with all stakeholders.
- Social safety nets and support during adaptation periods.

Channels

- Workshops and training programs on sustainable fishing and marine ecosystem knowledge.
- Direct consultations with fishing businesses.
- Community outreach and engagement.
- Special programmes for women
- Collaboration with financial institutions
- Collaboration with eco-tourism agencies.
- Mission to neighbouring countries/RFBs

Stakeholder/Target Segments

- Fishers and their communities.
- Fisher women
- Fishing businesses.
- Local and global consumers of fish products.
- Eco-tourism industry.
- Neighbouring countries (cooperation on shared fish stocks)

Cost Structure

- Research, surveys, and assessment costs.
- Training, education, and community engagement costs.
- Institutional development costs
- Infrastructure maintenance and development costs.
- Compliance, licensing, and certification costs.

Benefit Streams

- Net benefits from sustainable fishing.
- Grants, sponsorships, and tax breaks for sustainable practices.
- Licensing, certification, and branding of sustainable fishery products.
- Eco-tourism collaborations.

Business Model Canvas adopted from Osterwalder, A., & Pigneur, Y. (2010). Business model generation.

Executive Summary

The impact of climate change on marine ecosystems has put the marine fisheries sector in India at risk. Increasing seawater temperature, ocean acidification, sea level rise, changing current pattern, cyclone intensity, ocean oxygen and nitrate levels, and shifting fish stocks likely to pose significant challenges to the marine fisheries sector having an estimated cost of 1-2% of India's current GDP by 2050.

This report outlines strategies to promote sustainable fisheries development in an era of climate change. It is inferred from several independent studies and consultations on various aspect of fisheries sector conducted by the Bay of Bengal Programme Inter-Governmental Organisation (BOBP-IGO) between 2019-2023 in India.

Policy Recommendations

1. Enhancing Fisher Organization and Participation:

Issue: Engaging the large community of fishers effectively is challenging without functional organizations.

Recommendation: Promoting Fish Producers Organizations (FPOs) and Cooperatives and ensuring their active involvement through proper incentives. Support structures like cold storage and training programs will further empower these entities.

2. Real-time Data Reporting and Monitoring:

Issue: Ambiguities in marine fish stock status hinder data-driven fisheries management.

Recommendation: Implementing a real-time data reporting mechanism, equipping vessels with electronic logbooks, and fostering collaboration among national and international bodies for comprehensive stock assessments.

3. Ensuring Resilient Fish Stocks:

Issue: Non-selective fishing gear contributes to significant bio-economic losses.

Recommendation: Reducing juvenile fishing across the fisheries value chain, introducing guidelines for effective gear, and promoting innovative solutions to decrease bycatch.

4. Collaborative Action on Shared Ecosystems:

Issue: Major fisheries and fishing grounds are shared with neighbouring countries, necessitating collaborative management.

Recommendation: Promoting common goals, developing knowledge-sharing platforms, and strengthening/ building regional institutions for management of shared stocks.

5. Safeguarding Small-scale Fisheries (SSF):

Issue: Lack of clear definition for the SSF makes designing targeted programmes for safeguarding the SSF difficult.

Recommendation: Need to clearly define SSF at national level, incentivizing good practices, and implementing interactive governance mechanisms.

6. Promoting Energy-efficient Fishing:

Issue: The increased use of mechanical propulsion in fishing has escalated carbon emissions.

Recommendation: Use of alternative fuels, optimizing engine capacities, encouraging solar energy, and promoting energy-efficient fishing accessories.

7. Introducing Social Security Measures:

Issue: Fishers face business disruptions due to climatic events.

Recommendation: Parametric insurance scheme may be implemented to mitigate losses and ensure business continuity during disruptions.

8. Review of Welfare Programs:

Issue: Existing welfare schemes have scope to expand the climate outcomes, in addition to meeting the livelihood needs of fishers.

Recommendation: The welfare programs may consider integrating third-party credit guarantee scheme and green infrastructure principles in future projects.

9. Women empowerment and gender mainstreaming:

Issue: Strong evidence of gender disparity within fisher population which may be eroding resilience of the community.

Recommendation: The fisheries sector needs to be studied through a gender lens to enable appropriate policy responses. Women-specific requirements for adaptation and mitigation including access to climate funds, climate resilient technologies especially in post-harvest activities including storage, processing and end use.

10. Capacity building:

Issue: Periodic upskilling of Government officials is a key driver to address climate change.

Recommendation: Equipping government officials with comprehensive training in sustainable fisheries management, policy frameworks, and adaptation strategies with respect to climate impacts on fisheries and fishing communities. This, in turn, will enable them to collaboratively develop effective plans with communities.

Conclusion

The marine fisheries sector of India has come a long way since independence, and it is essential to anticipate and address the disruptions that climate change poses. The policies outlined in this brief aim to navigate the evolving economic landscape of the marine fisheries sector in India, promoting sustainable economic growth and resilience in an era of climate change. The policy recommendations, based on empirical evidence and stakeholder consultations, provide options to consider for policymakers to address the challenges and harness opportunities in the marine fisheries sector of India.

Contents

1.0 Introduction

As marine ecosystems are undergoing transformative changes due to climate phenomena, the fisheries sector faces substantial economic challenges. Altered tidal patterns, combined with changing ocean oxygen and nitrate levels, along with other observed and unknown impacts threaten the productivity and profitability of marine fisheries. Particularly at risk are coastal ecosystems, such as coral reefs, which play a crucial role in supporting diverse marine life.

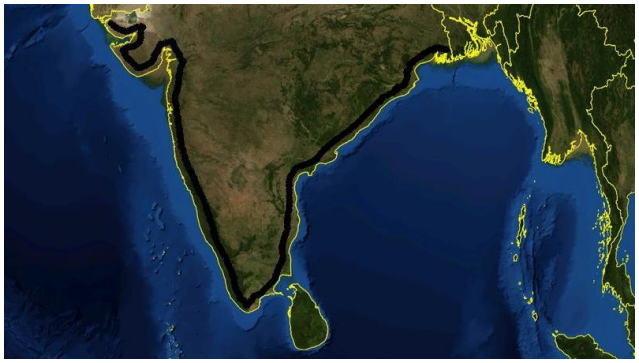

Fig. 1. Coastal Zone and Islands of India

In addition to uncertainties in fish production, challenges in market dynamics, resource management and territorial disputes translates to uncertainties in livelihood and income to the fishers. Intense cyclones, coastal erosion and storm surges aggravates the challenges. From an economic standpoint, it is vital for policymakers to anticipate and address these disruptions.

This report outlines adaptive strategies to navigate the evolving economic landscape of the marine fisheries sector, aiming to promote sustainable economic growth and resilience in an era of climate change.

2.0 Methodology

This report is built on findings from various empirical research and intensive stakeholder consultations conducted by the Bay of Bengal Programme Inter-Governmental Organisation (BOBP-IGO) between 2019-2023 in India on issues ranging from climate change adaptation; insurance as a tool for building resilience; fisheries technology; policy and research.

A diverse methodology was employed, encompassing focus group discussions (FGD) for in-depth stakeholder insights, interactive stakeholder workshops, expert panel consultations for expert opinion and validation, key informant interviews with industry leaders and policymakers, broad-based stakeholder feedback surveys, collaborative roundtable discussions, and adaptive webinars and virtual consultations during pandemic-induced restrictions.

Engaging over 300 diverse stakeholders, from scientists to fisherfolk and administrators, both domestically and internationally, this comprehensive approach ensures the policy recommendations are deeply rooted in empirical evidence, capturing the intricate challenges and opportunities in the marine fisheries sector.

Input: Studies and Workshops

- **Strategies for Adaptation to Climate Change in Fishing Communities** *(2019-2023; Supported by MoEFCC, GoI).*
- **International Symposium on Building Climate Resilience Through Insurance** *(2022; Supported by World Bank, Asian Fisheries Society)*
- **Insurance as a Resilience Tool for Marine Fisheries** *(2022-23; Supported by World Bank)*
- **Assessment of Fisheries Infrastructure Development Fund (FIDF):** *(2022-23; Supported by NFDB)*
- **International Symposium on Resilient Fishing Technologies** *(2023; Supported by FAO, ICES, DoF, GoI)*
- **Regional Dialogue on Climate-Resilient Marine Scientific Cooperation** *(Convened in 2023).*
- **Climate-Responsive Strategies for Artificial Reefs and Sea Ranching in South Asia** *(Investigated in 2023).*
- **Climate Adaptation in Small Scale Fisheries (SSF) & Eco-Innovations in the Fisheries Sector:** *(Explored in 2023).*

3.0 The marine fisheries sector of India

The marine fisheries sector of the country has come a long way since Independence. From subsistence fishery in the 1950s, the sector has transformed to become one of the top ten marine fish producers in the world.

India has a coastline of 8,118 km and an EEZ of 2.02 million sq. km (DoF, 2019) comprising 0.86 million sq. km (42.6 % of the total) on the west coast, 0.56 million sq. km (27.7%) on the east coast and 0.60 million sq. km (29.7%) around the Andaman and Nicobar Islands (Fig. 1). The continental shelf area amounts to 530 000 sq. km of which 71% area is available in the Arabian Sea (west coast) and the remaining 29% in the Bay of Bengal (east coast). There are also 3 477 fishing villages and 1 547 fish landing centres in the country which translates to a fishing village at about every two km interval along the coastline and a fish landing centre at every five km interval (Table 1).

Table 1: Coastal States and Union Territories of India, 2016

#	State/Union Territory	Coastal length (km)	Landing centres	Fishing villages
1	Andaman & Nicobar	1 912	51	169
2	Andhra Pradesh	974	350	533
3	Daman-Diu	27	12	12
4	Goa	104	34	41
5	Gujarat	1 600	107	280
6	Karnataka	300	115	162
7	Kerala	590	204	220
8	Lakshadweep	132	20	10
9	Maharashtra	720	173	526
10	Orissa	480	73	739
11	Pondicherry	45	41	39
12	Tamil Nadu	1 076	301	575
13	West Bengal	158	66	171
14	**INDIA**	**8 118**	**1 547**	**3 477**

Source: Marine Fisheries Census, 2016

Resources

The Potential Yield (PY) of Fishery Resources in the EEZ of India is estimated at 5.31 million tonnes. Demersal and pelagic resources contribute 43.28% and 49.56% respectively to the potential yield (Table 2). About 60% of the resources are located along the west coast covering the states of Gujarat, Maharashtra, Goa, Daman, Diu, Karnataka, and Kerala. Owing to the rich coastal waters, Indian marine fisheries were traditionally concentrated on near-shore waters.

The total fisher population of India is 3.77 million (2016). Tamil Nadu has the highest fisher population followed by Odisha and Andhra Pradesh. The marine fisheries sector employs about 1.45 million people directly in the value chain. Of which, 0.9 million fisher folks are engaged in active fishing and about 0.5 million fisher folks are engaged in various other fishing-related activities. About 24% of the fisher families that translate into 0.9 million fisher population are below poverty line. In terms of demographic

composition, adult males and females make up 34% and 33% of the population respectively. Children (below 18 years) make up about 33% of the population. About 16% of the population is below 5 years of age.

Table 2. PY estimate of Indian marine fisheries

Resource	Potential Yield (t)	Contribution (%)
Demersal (mainland)	22 98 281	43.28
Pelagic (mainland)	26 31 827	49.56
Lakshadweep (ex. oceanic)	14 490	0.27
A & N Islands (ex. oceanic)	43 794	0.82
Oceanic (for the entire EEZ)	2 30 832	4.35
Others	91 369	1.72
Total	**53 10 593**	**100**

Source: Handbook of Fishery Statistics, 2018

The marine fishing fleet comprises about 1,69,771 fishing crafts of which, 16% are traditional, and 59% are motorized traditional crafts. The mechanized fishing vessels (MFVs) comprise 42, 813 vessels – 25% of the total. However, 80% of marine fish production comes from MFVs.

Production trend

Marine fisheries production has increased from 0.53 million tonnes in 1950 to 3.69 million tonnes in 2019 with a cumulative annual growth rate (CAGR) of 3.10%. The highest landings were in 2017 when the volume increased to 3.95 million tonnes. Overall, during the last decade (2010-19), the average landing was 3.56 million tonnes, which is about 67% of the potential (Fig.2). However, the untapped potential is mostly in the deeper waters. It is likely that the near shore waters are fully exploited.

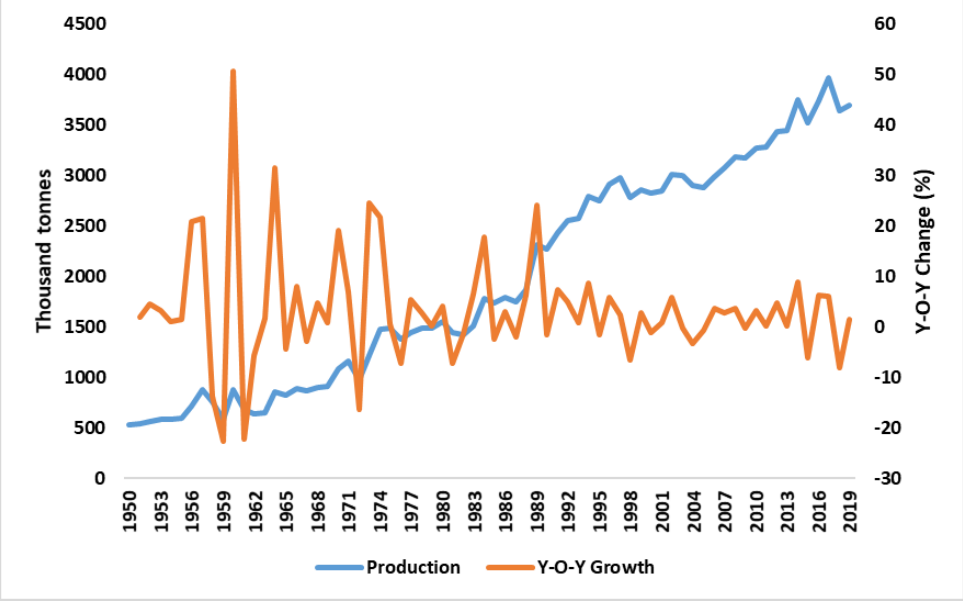

Fig. 2. Marine Fish Landings in India (Estimated from FAO FISHSTAT J database)

Indian Oil sardine constitute the major fishery of India. During 2000-19, on an average, Indian Oil sardines constituted about nine percent of the total landings followed by croakers (6.73%), prawns (5.77%), and Bombay-duck (4.92%) (Table 3). There was a spurt in the landings of the red-toothed triggerfish in 2019 as it emerged as the largest fishery. However, prior to that it was a minor fishery and could be an anomaly. During 2000-19, while most of the major fisheries experienced negative or moderate growth, Indian mackerel was an exception and recorded a double-digit growth with an increasing production trend. Clupeoids, jacks, and hairtails also showed relatively rapid growth during the period. The sudden fall in production of the Indian oil sardine during 2018-19 could be another anomaly.

Table 3. Major marine fisheries of India during 2000-19

Major fisheries	Average production (t)	Share (%)	CAGR
Indian oil sardine	3,06,094	9.34	-1.21
Croakers, drums nei	2,20,661	6.73	-3.30
Prawns	1,89,162	5.77	0.58
Bombay-duck	1,61,174	4.92	-1.83
Natantian decapods nei	1,52,086	4.64	2.05
Hairtails, scabbardfishes nei	1,43,954	4.39	4.16
Clupeoids nei	1,39,471	4.26	10.05
Indian mackerel	1,24,274	3.79	10.11
Anchovies, etc. nei	95,138	2.90	1.43
Sea catfishes nei	87,006	2.65	-1.28
Percoids nei	73,337	2.24	
Ponyfishes(=Slipmouths) nei	70,070	2.14	3.47
Jacks,	68,950	2.10	5.91
Cephalopods nei	65,541	2.00	
Sharks, rays, skates, etc. nei	65,457	2.00	-2.79
All species	**32,77,648**	**100.00**	**1.70**

Estimated from FAO Fishstat J Database. Nei = Not anywhere included.

In terms of fishing gear, mechanized trawl nets land about 50% of the production followed by dolnets (6.71%) and ring seines (6.28%). Outboard gillnets and ring seines contribute about 9% and 7%, respectively. Purse seine is another important gear that contributes about 6%. In recent years, there is an active promotion of longlining in India to target deep-sea fishes such as tunas. The trawlers usually target demersal fishes and prawns while the gillnetters and purse seiners target mackerels and sardines. Ring seiners were specially developed to target shoals of oil sardine.

The estimate of the value of marine fish landings during 2019 at the landing centre level was Rs. 60,881 crores. The unit price per kg of fish at the landing centre was Rs. 170.50. At the retail level, the estimated value was Rs. 92,356 crores and the unit price at the retail market level was Rs. 258.70 per kg. (CMFRI 2021).

4.0 Impact of climate change on marine fisheries sector of India

The International Panel on Climate Change (IPCC) in its latest report (AR6) highlighted that the century will witness significant and intensified changes in the ocean state, with high emission scenarios leading to widespread and multiplied warming by 2100. As a result, coastal regions are undergoing drastic changes including seawater warming, tidal shifts and a substantial decline in surface ocean pH, depletion of dissolved oxygen particularly under high emission scenarios.

The tropical Indian Ocean is particularly vulnerable to climate change with high chance of negative impact on coral ecosystems. Sea surface temperature (SST) of the tropical Indian Ocean has risen by 1°C on average during 1951–2015, markedly higher than the global average SST warming of 0.7°C, over the same period. Ocean heat content in the upper 700 m of the tropical Indian Ocean has also exhibited an increasing trend over the past six decades, with the past two decades (1998–2015) having witnessed a notably abrupt rise. SST is projected to increase by 1.2 and 1.6°C under RCP 4.5; and by 1.6 and 2.7°C under RCP 8.5 during 2040-2069 and 2070-2099, respectively.

With continued global warming and anticipated reductions in anthropogenic aerosol emissions in the future, CMIP5 models project an increase in the mean and variability of monsoon precipitation by the end of the twenty-first century, together with substantial increases in daily precipitation extremes. Resulting from the increased variability of monsoon precipitation and increased water vapour demand in a warmer atmosphere, climate model projections indicate a high likelihood of an increase in the frequency of drought intensity (>2 events per decade) in arid and semi-arid zones, and the area under drought conditions will increase in India by the end of the twenty-first century under RCP8.5 scenarios.

In the case of ecosystems and fisheries, shifts in distribution of fish stocks, and risks to coastal ecosystems, particularly coral reefs, are leading to changes in marine living resources, thereby to socio-economic conflicts.

> While there are adaptation and mitigation options available, timing is the essence. For example, coastal blue carbon ecosystems provide some mitigation possibilities and various adaptations including coral reef restoration and governance adaptations is contingent on addressing the overarching challenges posed by climate change.
>
> *The projected increase in SST is likely to change fish distribution further in the Indian seas, with the possibility of negatively changing population abundance.*

However, as of now, models estimated that the impact of climate change on global physical changes, ecosystems and ecosystem services including fisheries, though negative, is low (Fig. 3). However, this is not a guarantee that chaotic situations will not prevail in the future, given the limited observations and knowledge gaps.

The following table (Table 4) summarizes some major impacts of climate change on marine fisheries. However, given the feedback loop and knowledge gaps, there are possibilities for other significant impacts.

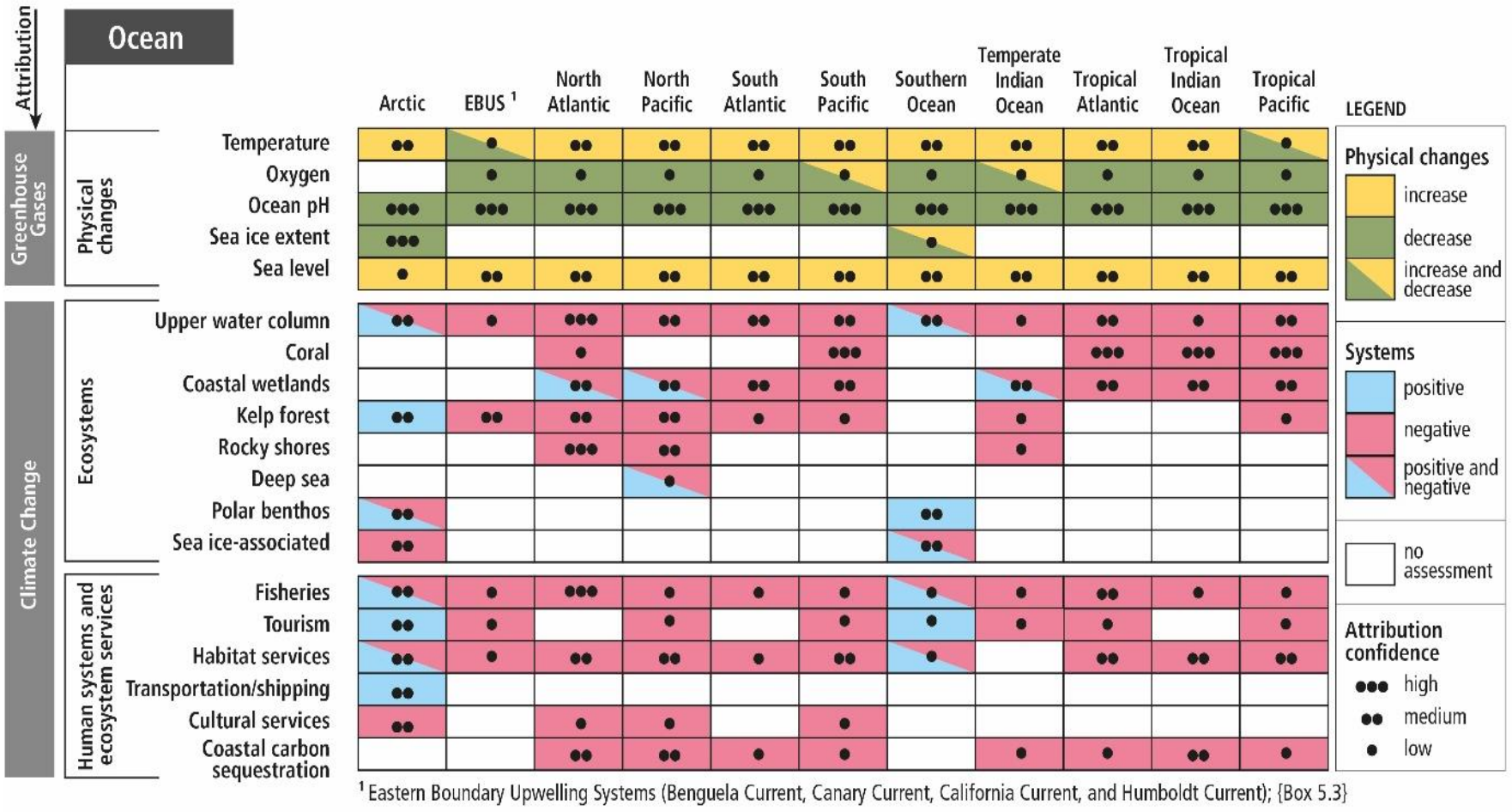

Fig. 3. Observed regional impacts from changes in the ocean and the cryosphere (Source: reproduced from IPCC)

Table 4. Impact of climate change on marine fisheries

Level 1	Level 2	Level 3	Level 4
Climate Change	Ocean Temp Increase	Shift in Fish Distribution	Altered Fish Catch Rates/ Loss of established fisheries
		Coral Bleaching	Economic Impact on Fishing Communities
			Loss of Coral Reef Habitats
	Ocean Acidification	Impact on Calcifying Organisms	Decline in Shellfish Populations
	Sea Level Rise	Coastal Flooding, loss of properties and assets	Displacement of Coastal Communities
	Changes in Ocean Currents	Disruption in Fish Migration Patterns	Altered Fish Catch Rates
	Increased Storm Frequency and Intensity	Damage to assets and infrastructure	Business disturbance
		Loss of fishing days	Loss of income from fishing

Case study 1: Fluctuations in the production of Indian Oil sardine

Indian oil sardine (IOS) is the largest fishery of India that contributed about 9% to the total landing, on an average, during 2000-19. Historically, IOS was available along the west coast and the state of Kerala was the major centre of IOS production. However, over, time, IOS fisheries started to develop along the east coast, though Kerala remains as the hotspot of IOS fishing. During 2021, there was 98% drop in IOS catch along the Kerala coast. At the national level, IOS catch dropped sharply from a peak of 545 thousand tonnes in 2014 to 134 thousand tonnes in 2020 (Fig. 4). In Kerala, only 3297 tonnes of IOS were landed against an average of 0.17 million tonnes during 2020.

Given that IOS is the mainstay of Kerala fisheries, such sharp decline severely affected the earnings of the fishers. The drop was a cumulative effect of El Nino Southern Oscillation (ESNO) and constant fishing pressure, as noted by a report of ICAR-CMFRI

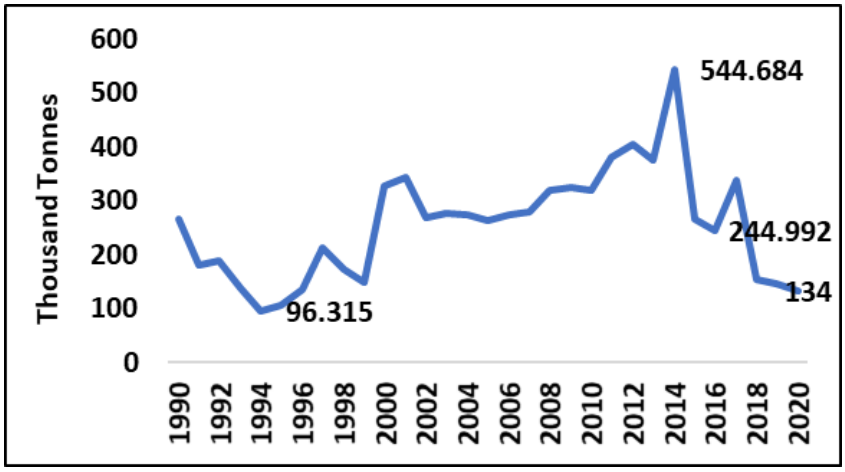

Fig. 4. Fluctuations in IOS Production in India (Source: FishStatJ)

Case Study 2: Loss of fishing opportunity and declining productivity – the Odisha case

In terms of loss of fishing days, depending on the development and intensity of a cyclonic storm, fishers are losing 10-15 days per year. This is roughly equivalent to USD 395 million, if projected at the national level.

Odisha is identified as one of the states in India most frequently affected by cyclones. During 2011-13, the state has faced two consecutive cyclones. Subsequently, during 2018-21, the state has faced four consecutive cyclones. We can also see that there was notable decline in marine fisheries production levels in Odisha in recent years. This decline is most pronounced between the years 2011 and 2013, with a reduction of nearly 50%. Prior to this period, there was a discernible upward trend in production. However, this trend has ceased post-2011 (Fig. 5).

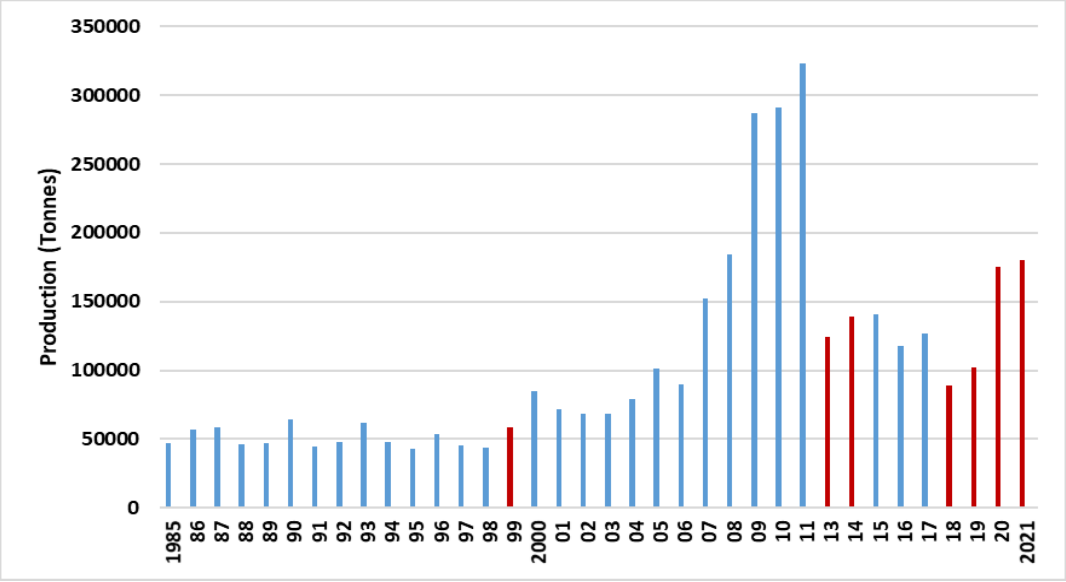

Fig. 5. Impact of cyclones (red bars) on marine fisheries production of Odisha (Source: CMFRI)

From the above one can infer a potential causal relationship between cyclonic events and the decrease in production. The data further suggest that cyclonic events during the specified timeframe had a significant impact on production. There could be several reasons for this relationship including destruction and damage of fishing assets and loss of fishing days, which might have contributed to the drop in production during post-cyclone period.

Event-specific example of loss from cyclone was noted during Cyclone Amphan. Cyclone *Amphan* made its landfall in West Bengal on 20th May 2020. It was a powerful and deadly tropical cyclone that caused widespread damage in eastern India, specifically northern Odisha, West Bengal, and Bangladesh. Four districts of Odisha namely Jagatsinghpur, Kendrapara, Bhadrak, and Balasore were affected severely by Cyclone *Amphan*.

ICAR-CMFRI estimated the loss due to the cyclone in the marine fisheries sector in Odisha at Rs. 10.59 crores including loss/damages of fishing craft at Rs. 996 thousand, damage to houses (kutcha/thatched houses) at Rs 460 thousand, and infrastructural damage at Rs 12 lakhs. The major chunk of the loss was from operational disturbances estimated at about Rs. 10 crores.

Case study 3: Increasing incidences of lightning

The frequency and intensity of lightning strikes in India are expected to increase by 10-25% and 15-50% by the end of this century. Coastal areas may be at the highest risk. Down To Earth [July 2021] reported that an increase of one degree Celsius would increase the frequency of lightning strikes by 12%.

> As per the data available from the National Crime Record Bureau, lightning was responsible for 40% of death from forces of nature in 2021. In general, number of deaths, due to forces of nature, is higher in the coastal states than that of inland states in India, the NRCB data shows.

Lightning is more likely to hit land than sea and that it is rare for strikes to occur in deep ocean areas. Waters just off coasts are more often affected. Therefore, the artisanal and marginal fishers are more at the risk of lightning strike. While there is no information available on it, newspaper reports show frequent deaths of fishers due to lightning (Table 5).

Table 5. Fisher's death due to lightning strike

Date	Place	Event	Type of vessel
31-Oct-21	Kerala	A fisher (32 years) died after being struck by lightning while he was fishing in the sea. The incident took place about 16 kilometres away from Thumba coast at 10.30 pm.	2 persons FRP Boats
12-May-21	Kerala	A young fisher (17 years) from the district died on Tuesday night after he was struck by lightning out at sea. The incident occurred around 9 p.m. around five kilometres off the Anchuthengu coast	5-person Small Boat
22-10-2021	Tamil Nadu	A lightning strike killed a fisher on-board a boat in the sea off the Tuticorin coast at 7 AM	Small Boat
11-10-2019	Tamil Nadu	One fisher (34 years) died while another was rescued when lightning. They were in sea off the Tuticorin shore around 7 – 7.30 AM.	2 – person boat
06-08-2019	West Bengal	Two fishers died and three other sustained critical burn wound due to lightning strike while fishing 7 nautical miles off the coast in the East Midnapore district of West Bengal	5-person Small Boat

Source: compiled from news reports

5.0 Economic implications of climate change on Indian marine fisheries

Potential loss from poor stock status

Species are vulnerable to both fishing pressure and climate change. These two factors can corroborate each other to significantly dent fisheries economics. The Table 6 below shows the major fisheries of India and their vulnerability to fishing and climate change.

> *As the data shows, out of 15 major commercial species, 8 species are vulnerable to climate change while 4 species are vulnerable to fishing pressure and three species are vulnerable to both fishing pressure and climate change, making them highly vulnerable fisheries in the future.*

One such species is sharks, a top predator, the collapse of which would have ripple down effect throughout the marine food web. This calls for an early adoption of the shark-plan in India[1].

Table 6: Vulnerability of major commercial species to fishing and climate change in India

Major fisheries	Species / Representative species	Fishing Vulnerability	Climate vulnerability
Indian oil sardine	*Sardinella longiceps*	Low	Moderate to High
Croakers, drums nei	*Otolithoides biauritus*	Moderate	-
Giant tiger prawn	*Penaeus monodon*	Low	High (CMFRI)
Bombay-duck	*Harpodon nehereus*	Low	Moderate to high
Natantian decapods nei	*Parapenaeopsis stylifera*	Low	-
Hairtails, scabbardfishes nei	*Trichiurus lepturus*	Moderate	High
Clupeoids nei	*Amblygaster sirm*	Low	-
Indian mackerel	*Rastrelliger kanagurta*	Low	Moderate to High
Anchovies, etc. nei	*Stolephorus commersonnii*	Low	-
Sea catfishes nei	*Plicofollis dussumieri*	Low	-
Percoids nei	*Nemipterus japonicus*	Low	High
Ponyfishes(=Slipmouths) nei	*Leiognathus equulus*	Low	-
Jacks,	*Caranx ignobilis*	High to Very High	High to Very High
Cephalopods nei	*Sephia pharaonis*	Low	-
Sharks, rays, skates, etc. nei	*Carcharhinus sorrah*	Moderate to High	Very high
Total average production (Tonnes)			**19,62,375**
Exposed to risk (Tonnes)			**11,32,402 (58%)**
Price per kg of fish at landing centre in 2019 (Rs)			**170.50**
Price per kg of fish at retail in 2019 (Rs.)			**258.70**
Estimated monetary value of fisheries production at risk (Crore Rs)			**19,307 – 29,295**

Compiled from Fishbase

[1] *BOBP-IGO and FAO in consultation with the scientist and other stakeholders developed the National shark Plan for India in 2015 under the BOBLME Project. A revised version of the same was submitted to the Department of Fisheries in 2018 and is currently under review.*

According to the findings of a study conducted by the ICAR-CMFRI[2], species on the east coast are more susceptible to climate change than those on the west coast. Around the Indian coast, almost 69% of the species assessed were very vulnerable. On the east coast, 72% of the investigated species were in the northeast zone and 77% were in the southeast zone, both of which were highly susceptible. About 30% and 33% (of the species evaluated) respectively were very susceptible in the southwest and northwest zones.

The study further noted that except for a few species (sharks, catfish, and green mussels), all the 69% of stocks that are classified as highly vulnerable to climate change because of resource overexploitation and climatic changes. All species are similarly exposed to climatic changes, and these stocks react to the change in climate and adapt to the change in environment in diverse ways. Nonetheless, the unwise utilisation of the resources makes them highly vulnerable.

- *In financial terms, potential exposure of 1.13 million tonnes of fisheries production (Table 6) translated into Rs. 19000 - 29000 crores at 2019 prices.*
- *It is likely that the impact would be higher in the east coast as compared to west coast. Roughly 400,000 fishers are directly under this risk while another 200,000 persons, mostly women may get affected along the value chain.*
- *Given the relative higher poverty of fishers in the east coast, it poses a significant risk to the rural economy of the country. The magnitude of financial loss of fishers may be partially offset by the increased price of fish, however, increased price may jeopardize nutritional security.*

Loss from shift and migration of fish stocks

IPCC has developed Representative Concentration Pathways (RCPs) to describe four different 21st century pathways of greenhouse gas (GHG) emissions and their consequences for the climate system. These are stringent mitigation scenario (RCP2.6), two intermediate scenarios (RCP4.5 and RCP6.0), and one scenario with high GHG emissions (RCP8.5). At the minimum, arresting at the level of RCP2.6 seems to be a challenge. In such a scenario, available scientific evidence shows that there is a strong possibility that climate change will have detrimental impact on marine fisheries sector of India[3].

- *In the EEZ of India's mainland, the catch potential is projected to decrease by 10.3 and 17.0% by 2050 under RCP2.6 and RCP8.5, respectively; and by 7.2 and 43.7% by 2095 under RCP2.6 and RCP8.5, respectively.*
- *In the Andaman & Nicobar Islands, the catch is projected to increase marginally by 0.25 and 1.5% by 2050 under RCP2.6 and RCP8.5, respectively; but reduce by 1.8 and 50.1% by 2095 under RCP2.6 and RCP8.5, respectively.*
- *The projected decrease in maximum catch potential may be driven by the direct effect of warming on fish physiology, by a decrease in their food availability (phytoplankton and zooplankton), and loss of habitat.*

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[2] *Zacharia P.U, A.P. Dineshbabu, Sujitha Thomas, Shoba Joe Kizhakudan, E. Vivekanandan, S. Lakshmi Pillai, M. Sivadas, Shubhadeep Ghosh, U. Ganga, K.M. Rajesh, Rekha J. Nair. T.M. Najmudeen, Mohammed Koya, Anulekshmi Chellappan, Gyanranjan Dash, Indira Divipala, K.V. Akhilesh, M. Muktha, Swathipriyanka Sen Dash, 2016. Relative vulnerability assessment of Indian marine fishes to climate change using impact and adaptation attributes. CMFRI Special Publication No. 125, (CMFRI-NICRA Publication no. 5), Central Marine Fisheries Research Institute, Kochi, India pp. 192.*

[3] *Cheung, W.W.L., J. Bruggeman and M. Butenschon. 2018. Projected changes in global and national potential marine fisheries catch under climate change scenarios in the twenty-first century. In: Barange, M., Bahri, T., Beveridge, M.C.M., Cochrane, K.L., Funge-Smith, S. & Poulain, F., eds. Impacts of climate change on fisheries and aquaculture: synthesis of current knowledge, adaptation and mitigation options. FAO Fisheries and Aquaculture Technical Paper No. 627. Rome, FAO. 63-86.*

Based on these scientific predictions, India is set to lose marine fish production of 16 to 22 million tonnes over the next 30 years valued at 2.6 to 3.6 lakh crores at 2019 prices. That is about 1 – 2% of the current GDP of the country.

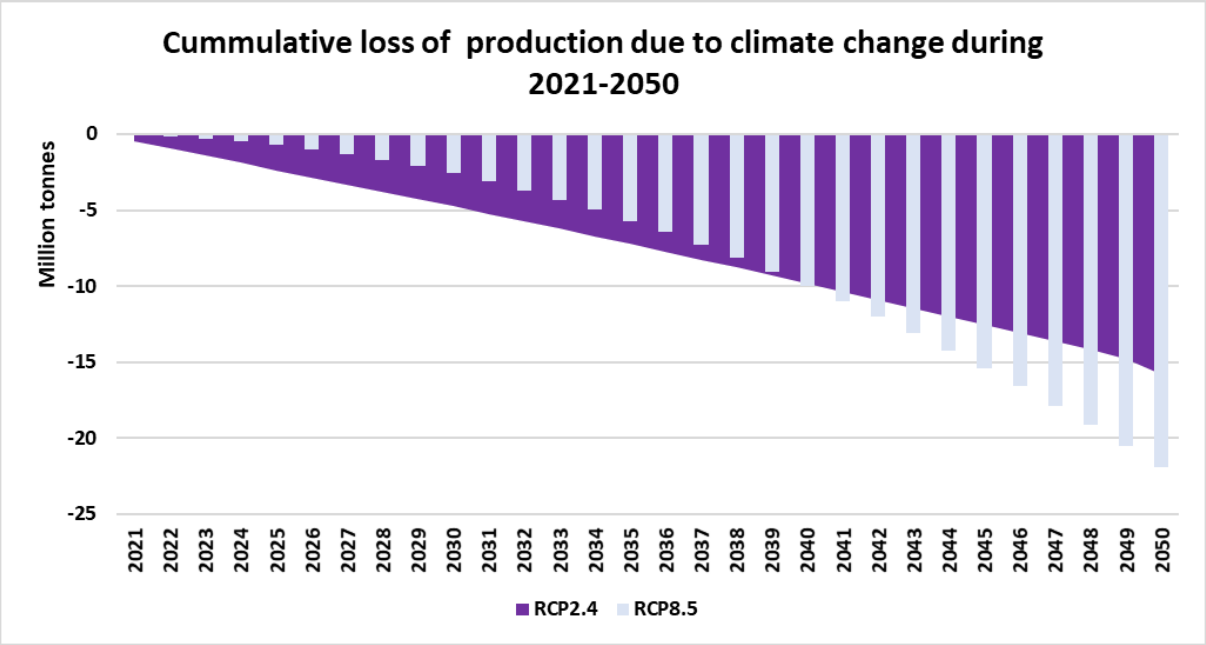

Fig. 6. Potential cumulative loss till 2050 under different RCPs

Apart from impact in fisheries, fisher population is also facing elevated risks of extreme weather events (EWEs), such as cyclones. In addition to increasing risks of life and property from EWEs, on an average, fishers have reported a loss of 10-15 fishing days in a year, due to harsh weather, resulting in monetary loss of about Rs. 158 crores per year.

6.0 Building resilience and adaptation planning: Issues and Policy Options

Policy Recommendation 1:

The Government should encourage fishers and facilitate their organization through economic institutions such as Fish Producers Organizations/ Cooperatives and create environment for making such organizations active.

Issue

India has over 1.5 million people engaged in fishing and fishing allied activities as per the national Marine Fisheries Census 2016. While active engagement of stakeholders is a primary condition for modern day fisheries management, it is a challenge to effectively engage with large number of stakeholders, who are acting independently. Therefore, it is high time to promote fishers and fishing allied organizations/ cooperatives.

Such a platform will ensure that a common interest is formed that can be acted upon. Moreover, a large number of members in the cooperatives are inactive, which again cannot serve any purpose. Therefore, affirmative actions are required to organize fishers and make such organizations active through designing proper incentives.

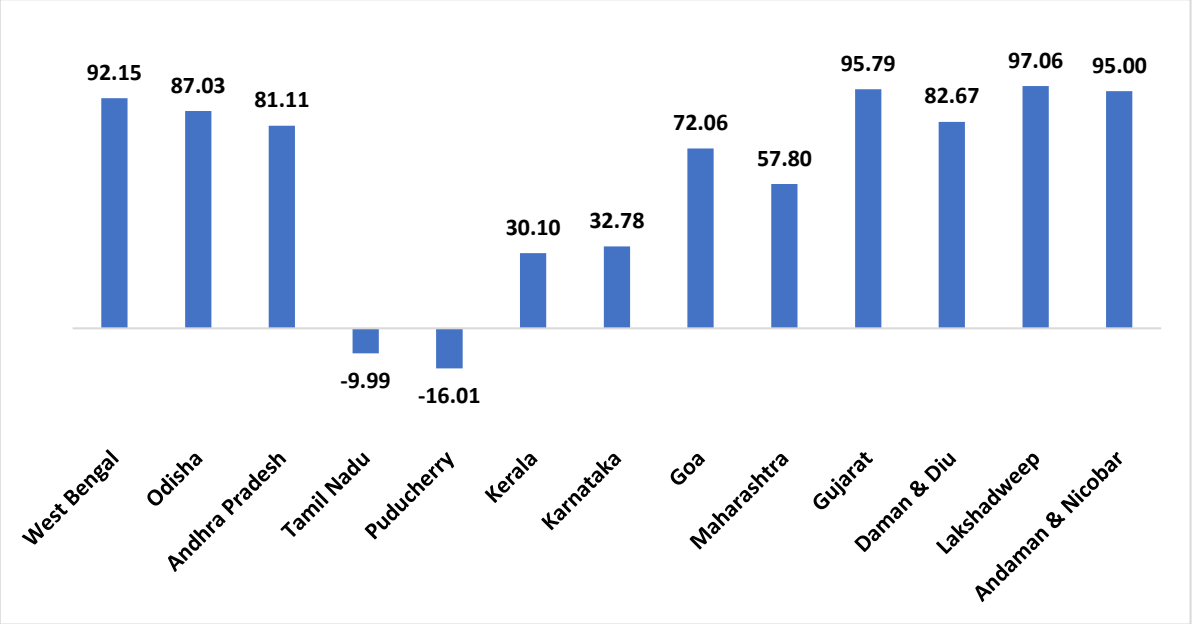

Fig. 7. Non-members as % of total occupied in marine fisheries (Estimated from Marine Fisheries Census, 2016)

Suggested actions

- **Enabling environment should be created** for strengthening fisher institutions such as cooperatives and various forms of fisher associations and their voluntary participation in resilience planning.
- **Enact or revise policies and regulations** that provide legal recognition to Fish Producers Organizations (FPOs) and Cooperatives as well as such other fisher organizations.

- **Enable formation of women's organizations** such as Joint Liability Groups, Self Help Groups, cooperatives and such institutions based on local need.
- **Organize regular training programs** to develop leadership, management, and technical skills among members of FPOs and Cooperatives.
- **Provide financial incentives** (grants, subsidies, low-interest loans, etc.,) to FPOs and Cooperatives.
- **Invest in infrastructure facilities** such as cold storage, processing units, and marketplaces dedicated to FPOs and Cooperatives. This will incentivize fishers to actively participate in the organizations.
- **Assess the functionality and impact of FPOs and Cooperatives** and recognize and reward the most active organizations while assisting lagging organizations.
- **Facilitate dialogues between FPOs/Cooperatives** and other stakeholders such as government agencies, NGOs, and private sector entities to ensure that all interests are aligned.
- **Establish a transparent and accessible feedback mechanism** where members can voice their concerns, suggestions, or grievances related to the functioning of the FPOs and Cooperatives.

Policy recommendation 2:

The Government may consider setting up of a mechanism for real-time data reporting mechanism and monitoring of stock status through implementation of MCS provisions in Marine Fishing Regulation Act, where applicable or through introduction of new regulations, if necessary.

Issue

There is some ambiguity over the stock status of the marine fish stocks in India. Currently, stock status is reviewed, and potential yield is estimated through a decadal exercise. The data for evaluation of stock status comes from at sea surveys of Fishery Survey of India and sample landing data collected by the ICAR-CMFRI. In addition, researchers bring out periodic publications on stock status, which are mostly used for academic purposes. Outside national jurisdictions, FAO, IOTC (for tunas), and SeaAroundUs project report on stock status based on catch data.

> *The current estimates are not available in real time and often there are years of lag, spatial discontinuity in the status of specific stocks, making them less efficient for management purposes, especially in the case of fully exploited or over-exploited stocks.*

Over-exploitation of fish stock is the primary cause of concern as it is making the sector highly vulnerable. As of 2016, 79% of fish stocks are exploited or over-exploited, showing a need for management. The volatility in production adds to business uncertainty for fishers, and the effects of climate change further increase uncertainty.

A rapid assessment method using fish catch data from FAO FISHSTAT J Database shows that out of 63 species for which data is available, 3% species are likely to be collapsed, 24% are overfished or overexploited, 25% species are developing, and 48% species are fully or overfished. A similar picture also appeared from the SeaAroundUs project, which uses a reconstructed data inclusive of discard and self-consumptions to monitor stock status.

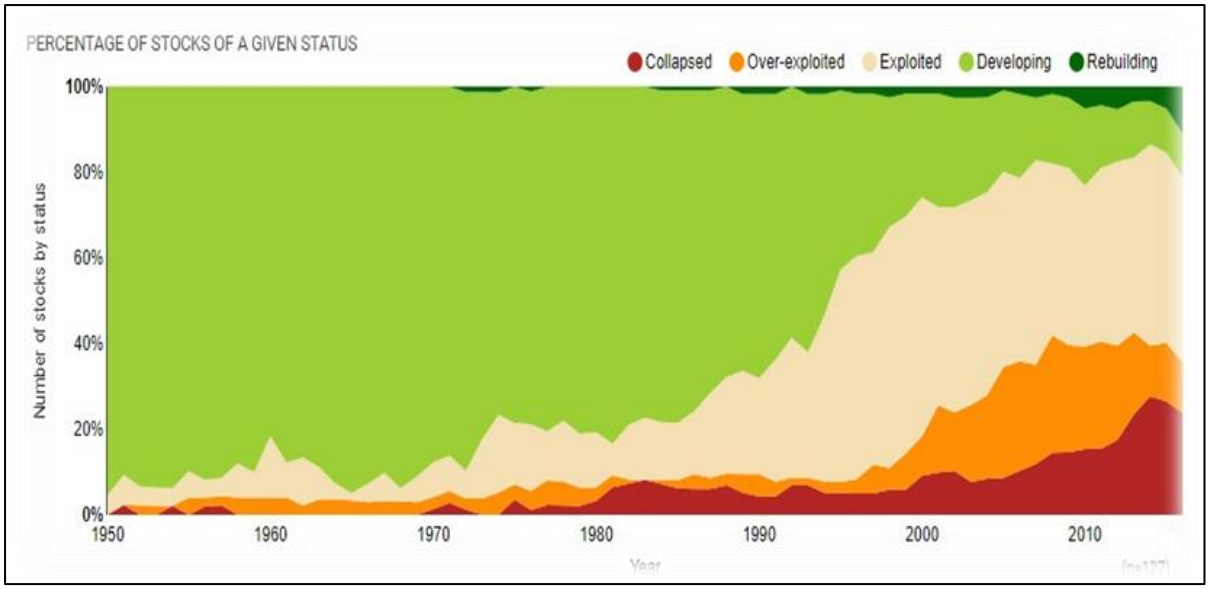

Fig. 8. Stock status in mainland India according to SeaAroundUs estimates

However, a recent comprehensive study by ICAR-CMFRI published in 2023 on the marine fish stock status in India reported that 91.1% of the 135 fish stocks assessed in 2022 were found to be healthy, underscoring India's commitment to sustainable marine fisheries and strengthening its stance at the WTO. The study also revealed that India harbours about 2,275 species of teleosts, 174 species of elasmobranchs, 3,400 species of molluscs, and 2,783 species of crustaceans. That is, only a small percentage of the fish stocks could be assessed possibly due to data limitations.

Suggested actions

- Develop a unified digital platform where all relevant agencies can input data in real-time. This platform can be equipped with analytical capabilities to assess stock status dynamically.
- Equip fishing vessels with electronic logbooks or tracking systems to report their catch data. This would help in obtaining real-time data from the source, ensuring prompt and accurate stock assessments.
- Facilitate collaboration between national institutes like ICAR-CMFRI, Fishery Survey of India, and international bodies like FAO and IOTC. Regular data sharing can help in achieving a comprehensive understanding of the stock status.
- Implement adaptive management measures based on the real-time data and stock assessments. This could involve implementing fishing quotas or imposing temporary bans on certain species, depending on their status.
- Educate fishers and stakeholders about the importance of real-time data reporting and sustainable fishing practices. Organize training sessions to familiarize them with the new tools and protocols.
- Mandate FPOs in helping in data collection and reporting.
- Develop AI based decision support tools to analyse and report findings through a public dashboard.

Policy recommendation 3

Market and technology interventions should be considered to ensure that stocks are healthy because healthy stocks are more resilient to climate change.

Issue

Use of non-selective gear and small mesh size are lingering problems in India and often reported in scientific studies and newspapers. Despite various legal and policy measures, the practice is still in vogue due to (1) existence of a market to offload such catch; (2) availability of gear conducive to juvenile fishing.

According to a recent release by the ICAR-CMFRI, 31% of threadfin breams caught from the Kerala coast in 2022 were juveniles (below the Minimum Legal Size-MLS). Due to this, the marine fisheries sector incurred a loss of Rs 178 crore.[4]

Suggested management interventions

- Focus across the value chain: The use of juvenile fish to be reduced in every stage of the fisheries value chain i.e., from capture to consumption, including post-harvest activities, distribution, and retailing. India has a decentralized fisheries production system with multiple entries and exits. Therefore, it is difficult to curb juvenile fishing at the point of production and consumption.

  One possible chokepoint could be aggregators/wholesales/distributors where stringent checks could be put in place to send signals up and downstream. To achieve this goal, it is necessary for the government to formulate a tailor-made sustainable consumption and production policy for the fisheries industry, especially taking into account the role of fishmeal industry.

- Develop guidelines for active gear, defining the mesh size and shape of mesh (e.g., square shape). Square mesh cod ends have shown better productivity in terms of reducing bycatch compared to diamond mesh cod ends. This approach contributes to sustainable exploitation by ensuring that only the desired size of fish is captured. Combining a flow-stopping funnel with a radial escape gap has proven effective in increasing the escape of undersized fish.

  For passive gear, traps made of materials such as stainless steel and HDPE bar mesh webbing may be promoted due to their heavy weight, resulting in better catch efficiency, lower discards, and reduced loss of fishing gear compared to PVC traps.

- Implement monitoring programs that use VMS and AIS. It should be followed by ex-post policy impact assessment via quantitative modelling. Any single innovative monitoring technology cannot be singled out as an effective policy instrument. It is necessary to employ a combination of technologies, complementing and communicating with each other, to provide effective results. Electronic Monitoring can be popularized among the fishers, which can be used for: (i) Gear deployment and retrieval; and (ii) Catch validation, Sorting, and processing.

- Introduce innovative solutions to reduce bycatch: To address the issue of high bycatch rates in pelagic longlining, innovative solutions such as the Shark Guard, designed based on shark electroreception, should be introduced. These deterrent devices help reduce shark interactions while targeting high-value tuna and billfish species.

- Effective implementation of Voluntary Guidelines on the Marking of Fishing Gear (VGMFG) is seen as a potential solution to prevent, reduce, and eliminate Abandoned, Lost or otherwise Discarded

[4] http://eprints.cmfri.org.in/id/eprint/17091

Fishing Gear (ALDFG). By marking fishing gear, effective traceability to the owner and operator can be ensured, contributing to better management and control of fishing gear loss.

- **Efficient recycling and responsible management** of End-of-Life Fishing Gear (EOLFG) and recovered ALDFG require the application of circular economy and Extended Producer Responsibility (EPR) principles. By implementing these principles, the fishing industry can strive towards sustainability by ensuring the proper handling and recycling of fishing gears.
- **Disposal of steel and FRP fishing vessels** after their lifetime should be brought under a regulatory framework as in the case of commercial cargo vessels (e.g., Ship Breaking code, MoS, GoI).

Policy recommendation 4:

The Government may consider supporting and strengthening of regional institutions and setting up mechanism for collaborative action on shared fish stocks and ecosystems.

Issue

The two major fishing grounds for India, Arabian Sea, and the Bay of Bengal large marine ecosystem (LME). One implication of LME is that resources and ecosystems are shared amongst the bordering countries. ***Resultantly, about 99% of marine fisheries catch of India comes from shared stocks (fish stocks occurring in more than one country or between a country and high seas).*** Most of the commercially important fish stocks, such as tuna, shrimps, hilsa (shad) are shared. Similarly, there are ecosystems such as the Sundarbans, Gulf of Mannar and Lakshadweep Sea that are also shared.

Therefore, there is a need to manage these shared resources through a collaborative effort. However, as of now, ***83% of the catch comes from fish stocks, which are not under any management regime, in this area***. There are marked differences in the availability of information and data collection amongst the sharing countries.

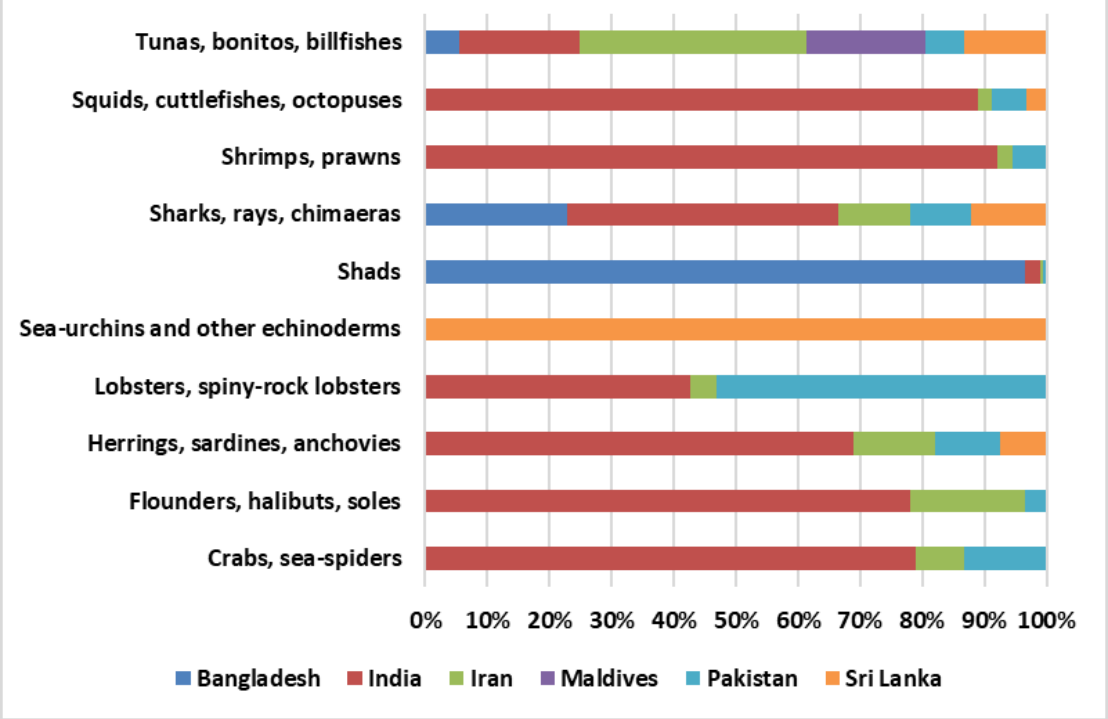

Fig. 9: Shared stocks in South Asia (Source: FishStatJ)

Suggested actions

- *Common goals* and objectives that align with the priorities of the neighbouring countries should be promoted ensuring a coordinated approach to addressing shared challenges and capitalising on mutual opportunities.
- *Robust communication* and knowledge-sharing platform that facilitates the exchange of ideas, best practices, and lessons learned, should be developed.
- *Cross-sectoral collaboration*, engaging stakeholders from the academic, research, governmental, and private service sectors to harness their collective expertise and resources in pursuit of shared goals should be promoted.
- *Adequate funding and resource allocation* mechanisms that support collaborative research, capacity-building, and policy advocacy efforts, driving the sustainable development and management of the marine fisheries sector should be ensured.
- *Strengthened institutional capacities*, enabling regional organisations like BOBP-IGO to lead and operationalize the networks and initiatives emerging from this collaborative framework should be ensured.
- *Regulatory institutions* such as regional fisheries management organizations should be promoted to or established to manage such stocks.

Policy recommendation 5:

The Government may consider clear policy direction to safeguard the interest of the small-scale fisheries (SSF) sector.

Issue

Safeguarding the interest of the SSF is well-established in international treaties, convention, and guidelines. For example, the Code of Conduct for Responsible Fisheries of FAO (1995) provides clear recommendations for safeguarding the interest of the small-scale fisheries. This was further expanded and strengthened in the Voluntary Guidelines for Securing Sustainable Small-scale Fisheries (SSF Guidelines, 2014). However, what comprises the SSF remain a topic of much debate. It is also well-accepted that the countries can define their own SSF.

Suggested actions

- Define SSF: A clear definition of small-scale fisheries is needed at the national level. A clear definition would facilitate *allocation* of resources available for activities contributing to the sustainable development and future proofing of SSF. For example, fishing vessels below 12 m in length may be considered small-scale fishing vessels.
- Incentivize Good Practices: It is also essential to find and reward responsible *métiers* and allocate fishing opportunities to these *métiers* to maximize environmental and social goals. At the same time, harmful fishing practices should be disincentivized. For example, non-trawl métiers should be given greater legal and policy protection through the declaration of designated fishing zones. These areas can come under the systems of protected areas or other effective area-based conservation measures (OECMs).
- Mainstream Interactive Governance: Interactive governance is based on a method of decision-making and management that engages various stakeholders and encourages collaboration and participation. An interactive governance mechanism for small-scale fisheries is needed to address

the challenges faced by these fisheries, such as overfishing, lack of access to credit and technology, and inadequate marketing infrastructure. The goal would be to create a more sustainable and fair fishing industry, which benefits the fishing communities, all stakeholders associated with each step of the SSF value chains and the broader society.

- **Enhance Social Security to Mitigate Climate Risks:** To make SSF sustainable, social protection like insurance should be provided. Training on post-harvest processing for women can also be introduced. A clear understanding of need and for social protection and issues in data gaps that impede development of insurance products, need to be addressed.
- **Mainstream Sustainable Fishing Practices:** Incentives should be created for embedding sustainable fishing practices by creating financial incentives through access to better markets providing a higher price for sustainably harvested fish.

Policy recommendation 6:

Energy efficient fishing practices need to be promoted in order to meet India's commitment on reduction of GHGs.

Issue

Over the years, use of mechanical means in marine fisheries has increased considerably in India. Presently, above 84% of fishing vessels in India use motors for propulsion. Coupled with fishing further from the shore and the increased duration of the fishing voyage, there is considerable carbon emission from the marine fisheries sector.

A 2013 study estimated that about 1.02 tonnes of CO_2 is emitted per tonne of catch[5]. However, a recent study (2023) by ICAR-CMFRI estimated carbon emission at 1.32 tonnes per tonne of catch[6]. It implies an increase of 29-30% over the last 10 years or about 2 - 3 % per year.

Suggested actions

- **Encourage the use of alternative fuels:** A significant part of the greenhouse gas emissions from fishing vessels could be attributed to the use of powerful diesel engines that have low efficiency, resulting in excessive fuel consumption and cost. Therefore, it is crucial to explore alternative fuels such as LPG and LNG for fishing vessels and scale up their use for commercial purposes. Additionally, the development and promotion of hybrid engines should be encouraged to reduce carbon emissions further.
- **Optimization of engine capacity:** It is important to determine the optimum engine capacity for vessels of varied sizes based on scientific research. Further, governments can set standards and regulations for the maximum engine capacity of fishing vessels based on their size and intended use. Ensuring that vessels work within a suitable range of engine capacity can aid in decreasing fuel consumption and emissions.
- **Promote the use of solar energy:** Government Schemes can be designed to encourage the use of solar panels to power small auxiliary machinery, which is currently being run by engine power or fuel energy, which can help reduce fuel consumption during fishing operations.

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[5] ***Vivekanandan, E and Singh, V V and Kizhakudan, Joe K (2013) Carbon footprint by marine fishing boats of India. Current Science, 105 (3). pp. 361-366.***

[6] ***Express News Service. (2023, March 13). Carbon emissions from India's marine fisheries sector much lower than global level: ICAR-CMFRI. The Indian Express. Last accessed on 13 October 2023 from https://indianexpress.com/article/india/kerala/carbon-emissions-indias-marine-fisheries-sector-icar-cmfri-8493282/***

- **Popularizing energy - efficient fishing accessories:** In India, rectangular flat otter boards are commonly used in demersal trawls. The government may phase out these traditional otter boards and provide different types of otter boards e.g., lightweight plastic trawl doors, V-form double-slotted otter boards, semi-pelagic self-adjusting otter boards, flying otter boards, and rubber ticklers, at a subsidized rate.
- **Scientific study on efficiency of multi-day fishing:** Multiday fishing on one hand would aid in reducing fuel consumption in fishing operations, while on the other hand would use larger boats with greater engine power, thus increasing the fuel use. Hence, systemic studies need to be commissioned to determine the net benefit of multi-day fishing in terms of energy use.

Policy recommendation 7

The Government may consider introduction of parametric insurance scheme or other social security measures to normalize the loss from business disruptions.

Issue

Fishers are facing difficult choices due to unexpected fluctuations in catch and loss of fishing opportunity due to harsh weather days. The cyclone season (May-December, Figure 9) coincides with the peak fishing season (October – February) causing significant loss to the fishers.

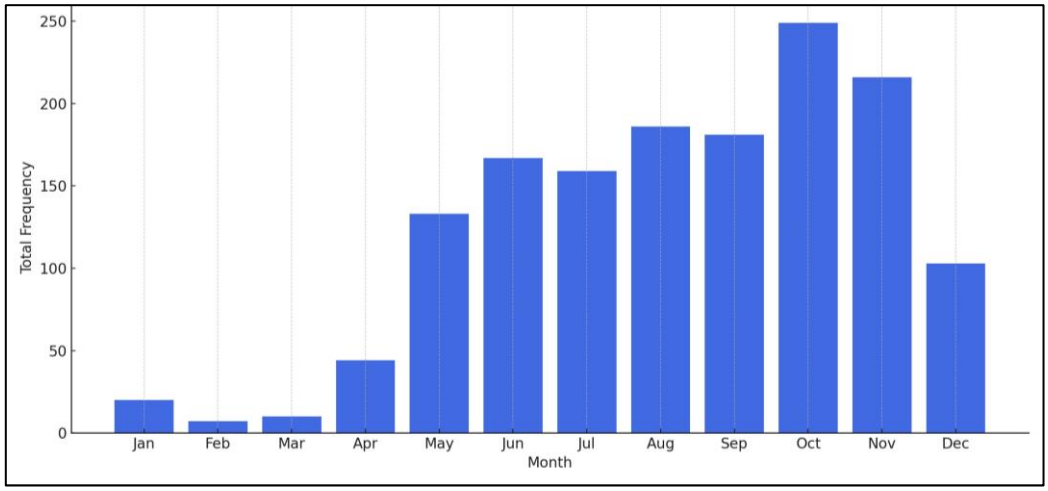

Fig. 10. Monthly distribution of cyclones and depressions (1891-2022) (Source: IMD)

Suggested actions

- **Develop parametric insurance programme**: Develop a Model Parametric Insurance Scheme to guide the insurance sector and implementation at pilot scale. Parametric or Index-based insurance can meet the business loss due to climate change.

  One example of parametric insurance could be Cyclone Insurance, where the fishing units (e.g., a boat owner) would be compensated at a fixed rate, once the event is triggered (that is there is a cyclone). The fixed rate will depend on the fund size. A specially designed parametric insurance (based on cyclonic disturbance) will be helpful for the fishers. Lessons can be drawn from the Fasal Bima Yojana, which imbibed parametric principals, and the Caribbean COAST Project.

- **Bulk insurance for fisheries assets:** Exploring the potential of utilizing tax revenue for purchasing bulk insurance for fishing assets such as boats which are uninsured or under-insured now.

Policy recommendation 8

The Government may consider reviewing various welfare and infrastructure development programmes and schemes to ensure better access of fishers to the schemes.

Issue

The Government (Central and State) is running various schemes to support fishers. Such schemes include development of infrastructure, business loan, purchase/upgradation of fishing vessels, etc. These schemes can play important role in facilitating the transition period. However, study shows that in many cases fishers are unable to access these facilities or the facilities provided (e.g., infrastructure) are not matching their current need. Thus, there is also a need to address current infrastructure shortfalls. A study conducted by the CICEF shows that there is a considerable shortfall of 34,000 safe landing and berthing places for mechanized fishing vessels (Fig. 11). However, these shortfalls are not uniform; some states also have the excess capacity as per the study.

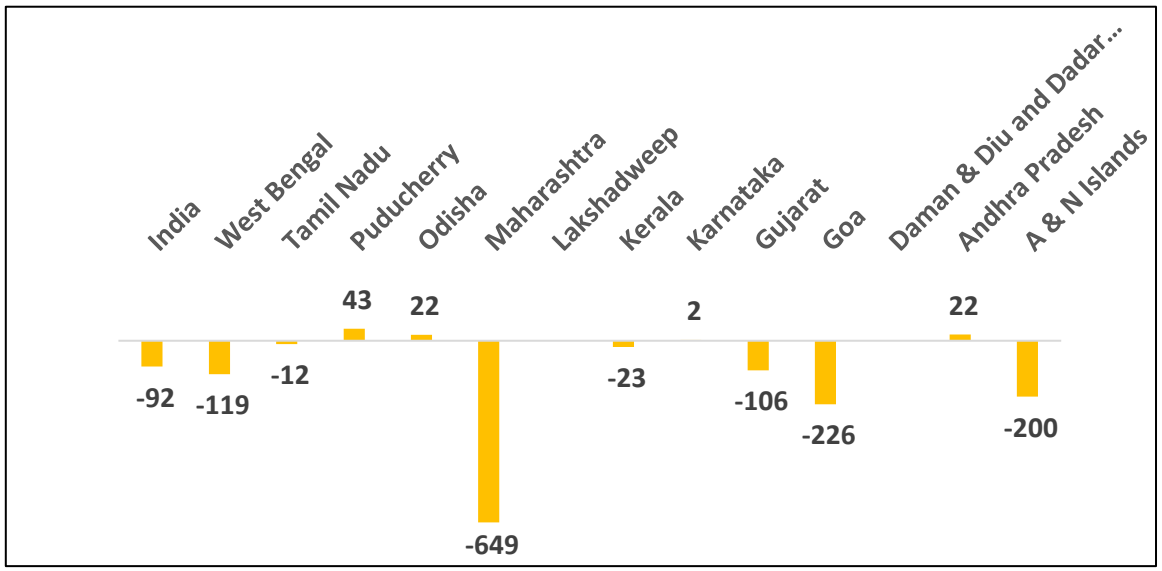

Fig. 11. Shortage of landing and berthing places in fishing harbours (%)
(Source: Handbook of Fishery Statistics, 2020, GOI)

Therefore, there is a strong case for review of welfare programmes and schemes to make them efficient.

Possible considerations

- **Third Party Credit Guarantee Scheme for Private Entrepreneurs and Cooperatives:** a significant barrier to securing bank loans for private Economic Entities (EEs) is the lack of sufficient collateral. This challenge is not unique to the fisheries sector but is a common concern for many Small and Medium-sized Enterprises (SMEs) globally. Over half of all nations now have Public Credit Guarantee Schemes (CGSs) to facilitate capital flow to SMEs. A credit guarantee scheme reduces third-party credit risk for lenders. By paying a fee, these schemes commit to absorbing a portion of the lender's losses on loans given to SMEs in case of a default. In India, the Credit Guarantee Fund Trust for Micro and Small Enterprises (CGTMSE) serves as a robust model, facilitating institutional credit flow to the Micro & Small Enterprises (MSEs) sector. Therefore, the Government may explore the feasibility of establishing this Third-Party Credit Guarantee Scheme, taking cues from the existing CGTMSE model. This would significantly boost private entrepreneurship and cooperative initiatives within the fisheries sector by easing their credit access challenges.

- **Convergence of various schemes under the Department:** Converging various schemes under the Department is crucial for enhancing the resilience and sustainability of marine fisheries amidst climate change. Such integration fosters efficiency, avoids duplication, and ensures a holistic approach to tackling the multifaceted challenges posed by climate change to the marine fisheries sector. A unified framework promotes coherent policy implementation, facilitates interdisciplinary collaboration, and optimizes resource allocation, thereby providing balanced support to all areas within the sector. Furthermore, it enables a streamlined monitoring and evaluation mechanism, encourages effective stakeholder engagement, and amplifies the impact of interventions through synergy. This coordinated strategy not only allows for the sharing of knowledge and best practices but also ensures agile and responsive action to the dynamic challenges presented by climate change, thereby safeguarding the livelihoods dependent on marine fisheries and contributing to the sector's sustainable development.

What is Green Infrastructure?

Green infrastructure is a strategically planned network of natural and semi-natural areas designed to deliver a wide array of environmental, economic, and social benefits. By adhering to these principles, we can ensure that our infrastructure projects are not only effective but also contribute positively to the environment and society.

Green Infrastructure Principles

1. **Multifunctionality:** Green infrastructure should serve multiple purposes, benefiting the environment, economy, and society concurrently.
2. **Sustainability:** Projects should emphasize long-term sustainability, ensuring that interventions remain effective and beneficial over time.
3. **Connectivity:** Green infrastructure should prioritize connected networks, allowing for ecosystems to thrive and species to migrate.
4. **Biodiversity Enhancement:** Interventions should promote diverse habitats, supporting a variety of flora and fauna.
5. **Natural Solutions:** Where possible, rely on nature-based solutions that harness the power of natural processes to address infrastructural needs.
6. **Integration:** Green infrastructure should be integrated into broader urban and rural planning strategies, promoting cohesiveness across projects.
7. **Climate Resilience:** Projects should emphasize resilience against climate change, ensuring infrastructure can withstand and adapt to changing environmental conditions.
8. **Stakeholder Engagement:** Engage communities and stakeholders in planning and decision-making processes, ensuring that local needs and perspectives are considered.
9. **Continuous Monitoring:** Regularly monitor and assess the performance of green infrastructure projects to ensure they meet intended goals and adapt to changing needs.
10. **Holistic Approach:** Consider the broader ecosystem and landscape, ensuring that interventions are not isolated but are part of a comprehensive environmental strategy.

- **Encouraging easy credit for sustainable activities: To** bolster sustainable fisheries and support vulnerable communities, the Government may contemplate preferential credit policies. These measures, such as increased interest subventions or subsidies, that unequivocally advance sustainable fisheries, like the installation of artificial reefs, are also being prioritized. This approach ensures equitable growth, promotes sustainability in fisheries, and aids in the long-term conservation of marine ecosystems.
- **Formation of an Expert Committee for Infrastructural Need Assessment:** The Government may consider establishing an Expert Committee under CICEF for Infrastructural Need Assessment, aiming to ensure targeted, sustainable, and environmentally responsive infrastructural development under the different programmes and schemes. This committee will focus on strategic assessments to prioritize needs, rationalize investments based on the enhanced allocation under various schemes, and incorporate the principles of green infrastructure, emphasizing environmentally beneficial projects. Simultaneously, it is essential that the committee's recommendations align with the WTO agreement on subsidies to ensure global compliance and promote fair trade practices. This holistic approach ensures infrastructural investments that are not only effective but also environmentally sustainable and globally harmonized.

Policy recommendation 09

The role and scope of women in marine fisheries sector need to be appreciated and strengthened.

Issue

Women constitute about 48% of total fisher population (2016) and 66% of fish allied activities. However, the fisheries sector across varied states in India is navigating through a pronounced gender disparity, prominently visible in aspects such as employment, literacy rates, and engagement in auxiliary activities. Males predominantly spearhead the primary fishing activities, as evidenced by an 88.66% employment rate in Andhra Pradesh compared to females' 28.43%. The females substantively involve into the sector's allied activities but often go unnoticed, such as in West Bengal where they account for approximately 23.86% (Fig. 12).

Furthermore, a literacy gap (Fig. 13), although less pronounced, suggests presence of systemic factors, hindering realization of full potential of fisher women. This divergence not only curtails the sector's productivity and economic vigour by underutilizing a crucial labour demographic but also potentially perpetuates gender stereotypes, thereby limiting socio-economic development and sustainability within the sector. Thus, addressing these disparities through gender-inclusive policies, educational initiatives, and capacity-building programs becomes imperative to foster a more equitable and sustainable future in fisheries.

Women are visible largely in post-harvest activities of sorting, cleaning and vending apart from processing (drying, salting, value addition). Unlike men, they often do not own significant assets (*e.g.* boats) and hence are unable to neither claim compensation post-disasters nor access safe finance for their livelihoods. They use open spaces or roadsides for their vending and processing activities and are affected by climate change related heat stress and extreme events. Shrinking coastal spaces due to erosion, lack of storage facilities and unseasonal rainfall can result in spoiling and loss of their processed catch.

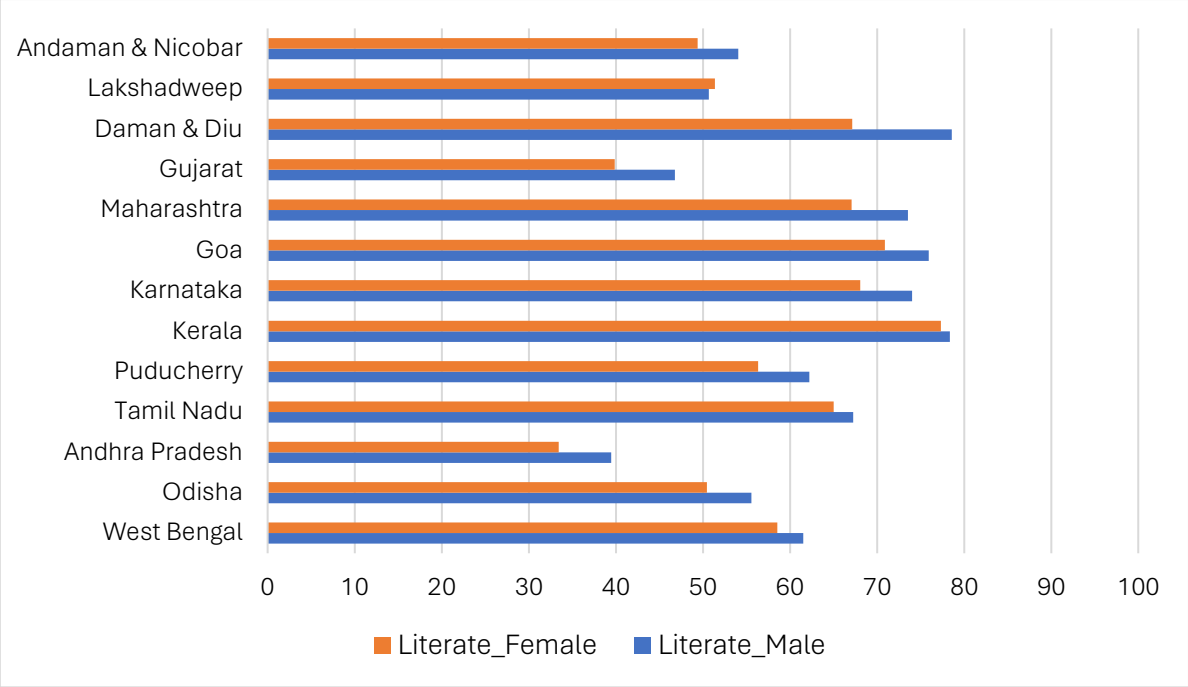

Fig. 12: Literacy by sex among fisher population (2016). Number of educated male (Female)/ Total number of male (female)

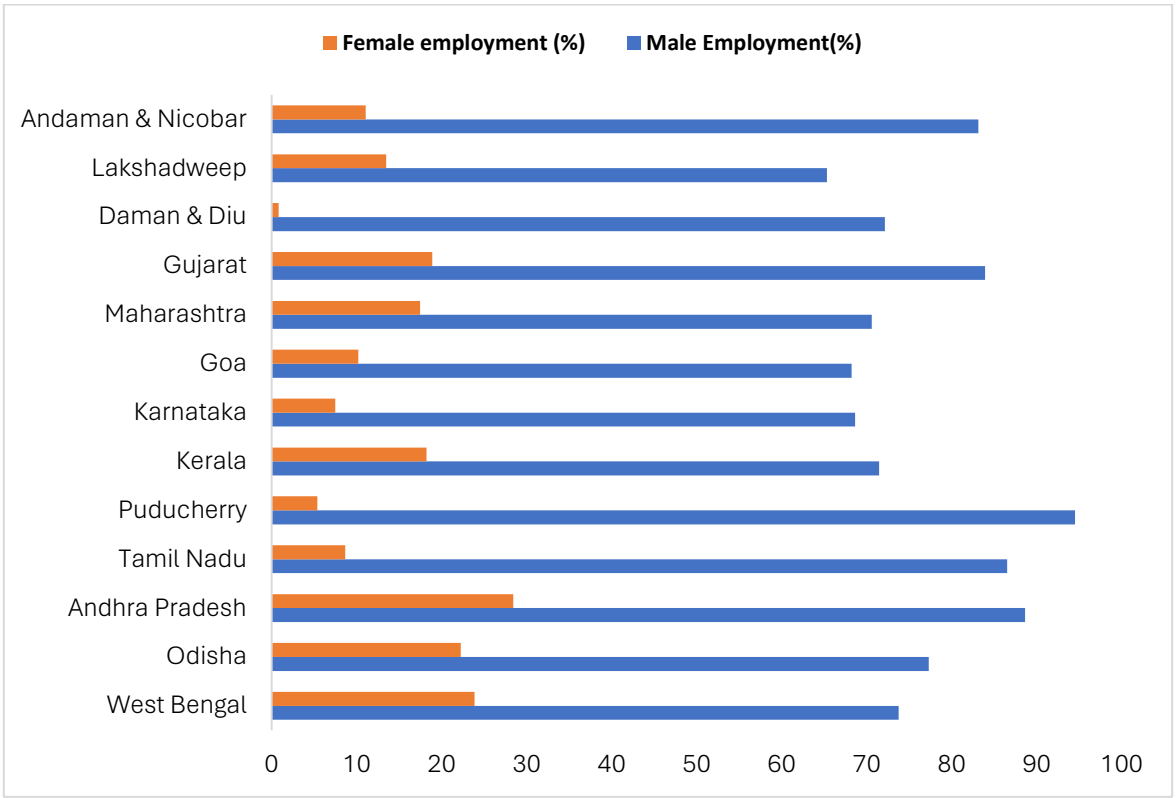

Fig. 13: Employment by sex (number of employed male (Female)/ Total number of adult male (female) (Source: Marine Fishing Census, 2016)

Suggested actions

Policy Interventions: Developing and implementing gender-inclusive policies that dismantle barriers, facilitating equal access to resources, training, and capital for females in the fisheries sector.

Capacity Building: Initiate programs that equip females with the necessary skills and knowledge to actively and proficiently participate in both fishing and allied activities.

Literacy and Education: Address literacy disparities through targeted educational programs and initiatives that empower females, enhancing their capabilities and involvement in the sector.

Research and Data: Engage in comprehensive research and data collection to further elucidate the gender dynamics within the fisheries sector, enabling more precise and impactful interventions.

Policy recommendation 10

Capacity building for effective delivery

In addressing the pressing challenges of climate change, it is vital for government officials to be equipped with the expertise to collaboratively devise adaptation plans with communities.

Therefore, a comprehensive training programme is recommended, encompassing key areas such as sustainable fisheries management principles, relevant policy and legal frameworks, socio-economic considerations, technological innovations, and specific adaptation strategies for coastal and marine fisheries.

This holistic approach would aid in ensuring that the officials are adept at formulating effective, community-inclusive, and resilient adaptation strategies in the face of environmental changes.

7.0 Conclusion

Climate change is a clear and imminent threat for mankind. The larger part of the challenge in adapting to climate change lies in our lack of understanding of the range of impact that climate change may create directly and through feedback loops. Therefore, the best bet seems to be that we prepare for the worst, while hoping for the best.

The policy options suggested in this brief resulted from several studies and consultations with large number of stakeholders and experts and represent our collective wisdom.

> *Many affirmative actions are already under implementation, across various functional departments of the Government of India such as coastal zone protection and developing green shield; ensuring zero pollution in coastal regulation zone; diversifying livelihood opportunities in coastal zones through eco-tourism and seaweed farming; installation of artificial reefs and exploring possibilities of sea ranching; harmonization of management measures between coastal states; curbing of IUU fishing, and implementation of ecosystem approach to fisheries management, all of which individually and collectively are contributing to building the resilience in marine fisheries sector.*
>
> *In additions, there are sectoral and sub-sectoral studies on adapting to climate change in India including the NICRA project. Synthesizing recommendations from such studies is also of utmost importance to keep them concurrent and to take informed decision. Various international organizations, such as FAO and national organizations of other countries, such as NOAA also periodically publish advisories and strategies, which should also be considered.*
>
> *We must understand that our knowledge of the natural system and how any disturbance in the natural system would play out is vastly incomplete. Hence, assimilating and drawing inference from multiple sources is essential. This report is a small step in that direction.*

Finally, the policy measures recommended in this brief are meant to supplement and not supplant the initiatives of the GoI towards this objective, so that the system remains resilient and vigilant to adapt to unforeseen challenges.

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The Bay of Bengal Programme Inter-Governmental Organisation (BOBP-IGO), set up in 2003, is a unique regional fisheries body, specifically mandated to assist the member countries in increasing the livelihood opportunities and improving the quality of life of the small scale/ artisanal fisher folk in the Bay of Bengal region. The current members of the Organisation are Bangladesh, India, Maldives and Sri Lanka while Indonesia, Malaysia, Myanmar and Thailand are cooperating non-contracting parties.

The core objectives of the BOBP-IGO are to increase awareness and knowledge of the needs, benefits and practices of marine fisheries management; enhance skills through training and education; transfer appropriate technologies and techniques for development of the small scale fisheries; establish regional information networking; and promote women's participation in marine fisheries value chain.

The Organisation evolved from the erstwhile Bay of Bengal Programme of the Food and Agriculture Organization (FAO) of the United Nations (UN) founded in 1979. Over four decades of operation, the Organisation has worked closely with the whole range of the stakeholders including the R&D Institutions to develop pathways to capacity enhancement for a sustainable future of the region. It has set international benchmarks in execution of programs and activities in the field of small - scale fisheries that has translated into measurable benefits for the member countries.

For further details, please see: www.bobpigo.org

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